International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Effectiveness of High-Frequency Chest Wall Oscillation in Pulmonary Rehabilitation: An Evidence-Based Analysis

Desai Kruti Sunilbhai[1], Kinjal Daru[2], Desai Drashti Sunilbhai[3], Niki Daru[4], Pooja Atul Desai [5]

[1]Assistant Professor, Physiotherapy, NAMO College of Allied Health Sciences
[2]Physiotherapist, Physiotherapy, NAMO Hospital
[3]Associate Dentist
[4]Doctor of Pharmacy
[5]Head Biomedical Engineer, Sevamed Solutions Private Limited

Abstract

Chronic respiratory diseases such as chronic obstructive pulmonary disease (COPD), bronchiectasis, and cystic fibrosis are frequently associated with impaired mucociliary clearance and mucus retention, leading to airflow obstruction, recurrent infections, and compromised pulmonary function (Hardy, 1994; Tomkiewicz et al., 1994). High-Frequency Chest Wall Oscillation (HFCWO) is a non-invasive airway clearance technique that delivers rapid chest compressions via an inflatable vest to facilitate secretion mobilization (AbdelAzeem et al., 2024; Nicolini et al., 2013). This evidence-based review aimed to assess the clinical effectiveness of HFCWO as part of pulmonary rehabilitation. A comprehensive literature search across PubMed, Scopus, Cochrane Library, and CINAHL included studies published between 2013 and 2025, with randomized controlled trials, systematic reviews, and clinical trials involving adult patients assessed using CASP and JBI appraisal tools. Eight studies, including four RCTs and four experimental trials, were included. Results demonstrated statistically significant improvements in airway clearance, FEV_1, and health-related quality of life in patients receiving HFCWO compared to conventional chest physiotherapy (Huang et al., 2022; Seifer et al., 2020; Ibrahim & Abdellatif, 2020). Additional benefits included improved patient adherence, comfort, and reduced healthcare utilization (Camacho Urribarri et al., 2024; Alahmari et al., 2017). The findings support the integration of HFCWO as an effective adjunct in pulmonary rehabilitation protocols, especially for patients with chronic mucus retention.

Keywords: HFCWO, Pulmonary Rehabilitation, Airway Clearance, Respiratory Therapy

INTRODUCTION

Chronic respiratory diseases such as Chronic Obstructive Pulmonary Disease (COPD) and non-cystic fibrosis bronchiectasis are associated with persistent inflammation, mucus hypersecretion, and impaired mucociliary clearance, leading to recurrent infections and functional decline. These conditions impose a substantial burden on healthcare systems due to frequent exacerbations, hospitalizations, and increased antibiotic use.(1,2)

Pulmonary rehabilitation programs aim to improve respiratory mechanics, exercise tolerance, and quality of life using a combination of exercise training, education, and airway clearance techniques (ACTs). Among the ACTs, High-Frequency Chest Wall Oscillation (HFCWO) has emerged as a non-invasive, patient-driven method for airway clearance. This technique uses an inflatable vest to deliver oscillatory airflow, promoting mucus mobilization and expectoration with minimal dependence on therapist-administered interventions. [3,1]

HFCWO was originally designed for individuals with cystic fibrosis but is now increasingly applied to conditions like COPD and bronchiectasis. Evidence suggests that HFCWO can improve sputum clearance, reduce acute exacerbations, shorten hospital stays, and enhance patient-reported outcomes. Huang et al. (2022) showed that HFCWO significantly increased expectorated sputum volume and decreased hospital length of stay in patients with acute exacerbation of COPD.[2] Similarly, Camacho Urribarri et al. (2024) demonstrated a notable reduction in healthcare resource utilization and economic burden following HFCWO adoption in bronchiectasis patients.[3]

High-Frequency Chest Wall Oscillation (HFCWO) is a mechanical method of airway clearance that delivers rapid compressive pulses to the chest wall using an inflatable vest connected to an air pulse generator. These oscillations enhance secretion mobilization by loosening mucus from the bronchial walls and promoting its movement toward larger airways for expectoration. This technique is non-invasive, easy to use, and well-tolerated by most patients, making it a potentially valuable adjunct to pulmonary rehabilitation protocols.[4,5]

This evidence-based practice review aims to evaluate the effectiveness of HFCWO in improving airway clearance, lung function, exercise capacity, and quality of life in patients undergoing pulmonary rehabilitation.

Application

- The manufacturers recommend that the patient must undergo this therapy while on upright or sitting position and concomitantly receiving aerosol bronchodilator therapy. The HFCWO treatment is started at low pressures and frequency and then increased to the recommended pressure/frequency as per patient tolerance.
- Different frequencies, from low (7 to 10 Hz) to
- Medium (10 to 15 Hz) and then to
- High (15 to 25 Hz), to achieve both higher flow rates and increased lung volume.

These therapy sessions generally last about 30 minutes and should not be performed on patients with significant hemoptysis. Despite these restrictions, these devices have been shown to mobilize more secretions than standard CPT in small clinical trials. More research is needed to determine its efficiency, cost benefits and optimum treatment strategies.[7,9]

Figure 1: High-Frequency Chest Wall Oscillation Device

Need for the Study

Despite the growing body of evidence, HFCWO remains underutilized in many pulmonary rehabilitation settings, especially in non-cystic fibrosis conditions. Variability in outcomes and heterogeneity in study designs highlight the need for a focused review of HFCWO's effectiveness across clinical contexts. Moreover, there is a paucity of consolidated evidence tailored to rehabilitation professionals seeking to integrate HFCWO into routine protocols. The literature is limited to show the effect of high frequency chest wall oscillation device in pulmonary rehabilitation

Aim of the Study

This evidence-based practice review aims to evaluate the effectiveness of High-Frequency Chest Wall Oscillation in improving sputum clearance, pulmonary function, exercise tolerance, and healthcare outcomes in adults undergoing pulmonary rehabilitation.

Methodology

A systematic search was conducted in databases including PubMed, Scopus, CINAHL, and the Cochrane Library. The search terms used were: "high-frequency chest wall oscillation," "HFCWO," "pulmonary rehabilitation," "airway clearance," "COPD," and "bronchiectasis." Boolean operators such as AND/OR were used to combine keywords. The inclusion criteria were:

1. Peer-reviewed articles published between January 2013 and March 2025,
2. Studies involving adult participants undergoing HFCWO as part of pulmonary rehabilitation,
3. Randomized controlled trials, systematic reviews, or high-quality observational studies, and
4. Articles published in English.

Each study was critically appraised using the Critical Appraisal Skills Programme (CASP) checklist for randomized trials and the Joanna Briggs Institute (JBI) tools for observational studies. Studies were included if they met a minimum quality score threshold and addressed relevant outcome measures such as pulmonary function, airway clearance, functional capacity, or patient-reported outcomes.

Database	Number of results	Articles identify as potentially relevant from reading title	Number of articles analyzed
Google scholar	446	18	3
PubMed	90	12	1
Cochrane	6	0	0
Cinhal	627	10	1
Total	1169	40	5

Selection of relevant articles

- Results from each database search were assessed for all potentially relevant articles by reading the titles
- Abstracts were then studied to ensure whether article met the inclusion criteria
- All articles that were relevant were obtained in text to be critically analyzed.

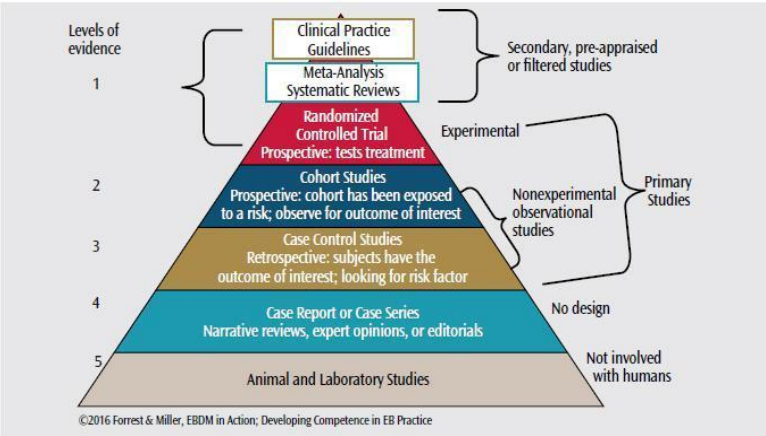
Primary Research Finding= 1169

Pub Med= 90, Google Scholar= 446, Cochrane= 6, Cinahal=627.

Potentially Relevant =8

Excluded n = 35

Levels of Evidence



Experimental Study (n=4)	Randomized Control Study (n=4)

Present study includes

Description of Articles

Type of study	A Randomized control trial (2013) – Google scholar
Title	Effectiveness of treatment with high-frequency chest wall oscillation in patients with bronchiectasis
Method	30 patients were enrolled. divided the patients into three groups: – 10 patients treated with HFCWO by using the Vest Airway Clearance System; – 10 patients treated with traditional techniques of air way clearance (PEP bottle, PEP mask, vibratory positive expiratory pressure); – 10 patients received medical therapy only (control group). CPT secretion clearance sessions lasted 45 minutes per session; HFCWO lasted 30 minutes per session. Both treatments were given twice daily. The duration of each treatment was fifteen days: the treatment was administered five days per week.
Outcome measure	Breathlessness, Cough, and Sputum Scale (BCSS), COPD Assessment Test (CAT) and Modified Medical Research Council (MMRC) Dyspnea Scale, PFT
Conclusion	The HFCWO technique provides an improvement both in pulmonary function and quality of life related parameters in patients with chronic hyper secretive disease.
Level of evidence – 1 **PEDro Score- 8**	

(11)

Type of study	An experimental study (November 2017) – Google scholar
Title	Utility of vest high frequency chest wall oscillation device versus flutter device in acute exacerbation of chronic obstructive pulmonary disease
Method	Study on 108 out of 129 patients presented with AECOPD, recruited from two-university hospitals. They were classified into three groups, HFCWO group, Flutter group, and control group. The HFCWO group and Flutter group were treated with AECOPD medications in addition to either HFCWO or Flutter physiotherapy, three sessions per week, for four weeks, while control group was treated by medications only. All patients were evaluated before and after treatment by spirometry, ABG, CAT score, and the BODE index.
Outcome measure	Spirometry -PFT, ABG, CAT score, and the BODE index.
Conclusion	Both vest HFCWO and Flutter device are highly effective in treatment of patients with AECOPD in terms of improvement in ventilatory function and oxygenation parameters with better exercise tolerance.
Level of evidence – 1	

(12)

Type of study	Systematic Review and Meta-Analysis of RCTs (April 2020)– Google scholar

Title	Effects of High-Frequency Chest Wall Oscillation on Acute Exacerbation of Chronic Obstructive Pulmonary Disease
Method	Review included 13 RCTs with 756 AECOPD patients. Databases searched till March 2022. Data analyzed via RevMan 5.4. Outcomes: sputum volume, FEV_1, ABG, hospital stay. Risk of bias assessed using RoB 2.
Outcome measure	Sputum expectoration, Length of hospital stay, FEV_1, PaO_2, $PaCO_2$, SpO_2, Dyspnea scale (mMRC)
Conclusion	HFCWO significantly improved sputum clearance (↑6.18 mL) and reduced hospital stay (↓4.37 days). No significant improvement in FEV_1 or ABGs overall, but subgroup analyses showed benefit over conventional therapies.
Level of evidence – 1	

(2)

Type of study	An experimental study (April 2020) – Google scholar
Title	Real-life experience with high-frequency chest wall oscillation vest therapy in adults with non-cystic fibrosis bronchiectasis
Method	Data from 2596 patients from a registry of adult bronchiectasis patients using HFCWO therapy was used to evaluate hospitalization patterns before and after initiation of HFCWO therapy, as well as antibiotic use and self-reported metrics of quality of life. Self-reported outcomes were also reviewed by cross-checking with sampled patient charts and found to be consistent.
Outcome measure	Likert scale, PFT
Conclusion	NCFB patients showed improved self-reported outcomes associated with the initiation of HFCWO therapy as measured by number of hospitalizations, antibiotic use, and the subjective experience of airway clearance. The improvement was observed early on after initiation of therapy and sustained for at least 1 year.
Level of evidence – 1	

(13)

Type of study	A randomized, open-label, crossover pilot study (April 2020) Pub med
Title	The effectiveness of a mobile high-frequency chest wall oscillation (HFCWO) device for airway clearance
Method	CF patients were treated with each device. Sputum was collected during and after each therapy session, while spirometry tests, Brody score assessment and functional respiratory imaging were performed before and after treatments, treated with m HFCWO or s HFCWO. Patients received the alternate treatment. All subjects enrolled in the study performed one-morning treatment per session, four of them also performed an afternoon treatment. Treatments lasted 30 minutes and were done using intensity settings of 6 to 10,

Outcome measure	Spirometry measures included PFT-FEV1, forced vital capacity (FVC) and FEV1/FVC.
Conclusion	The newly developed mobile device provides airway clearance for CF patients comparable to a non-mobiles HFCWO device, yielding a change in airway geometry and patency by the shift of mucus from the more peripheral regions to the central airways.
Level of evidence – 1 **PEDro Score -7**	

(14)

Type of Study	A Randomized controlled study design (2020) – Cinhal
Title	Does High Frequency Chest Wall Oscillation Have an Impact on Improving Pulmonary Function in Patients with Smoke Inhalation Injury?
Method	60 smoke inhalation injury patients were randomly distributed into 2 groups of equal size. Group A: received high frequency chest wall oscillation and conventional chest physical therapy (breathing exercises, early ambulation and cough training) thrice per week for 8 weeks. Group B: received traditional chest physical therapy (breathing exercises, early ambulation and cough training) thrice per week for 8 weeks
Outcome measure	Spirometry (FVC, FEV1, PEFR)
Conclusion	High frequency chest wall oscillation has an impact on improving pulmonary function and should be handled to be a part of the pulmonary rehabilitation plan for smoke inhalation injury patients.
Level of evidence- 1 **PEDro Score- 8**	

(15)

Type of study	Quasi-experimental study (April 2024) – Google scholar
Title	Effect of High-Frequency Chest Wall Oscillation Vest Device Versus Chest Physiotherapy on COPD Patients' Outcome
Method	90 COPD patients were randomized into two groups: one received HFCWO (n=45), the other chest physiotherapy (n=45); outcomes assessed at baseline, 1 week, and 2 weeks using sputum volume, mMRC Dyspnea Scale, and 6-Minute Walk Test.
Outcome measure	Expectorated sputum volume \n- C-reactive protein (CRP) levels \n- Dyspnea severity (mMRC scale) \n- 6MWT distance
Conclusion	HFCWO was more effective than chest physiotherapy in improving sputum clearance and reducing inflammation (CRP), but no significant difference in dyspnea or walking distance was found between groups.
Level of evidence – 2 **PEDro Score- 6**	

(1)

Type of study	An experimental study (April 2024) – Google scholar
Title	Impact of High-Frequency Chest Wall Oscillation on Health Care Resource Use and Economic Outcomes in Adult Patients With Non-Cystic Fibrosis Bronchiectasis
Method	Retrospective analysis using the IQVIA PharMetrics claims database (N = 255). Compared 12 months before and after HFCWO initiation. Outcomes assessed: hospitalizations, exacerbations, antibiotic use, costs.
Outcome measure	Inpatient hospitalizations and LOS \n- Acute exacerbation rates \n- Use of antibiotics \n- Pulmonology visits, radiology/lab tests \n- Healthcare costs
Conclusion	HFCWO therapy was associated with significant reductions in disease-specific hospitalizations, exacerbations, and healthcare resource utilization. Total cost decreased only when device cost excluded.
Level of evidence – 3	

(3)

Result

A total of 8 studies were included in the final review: 4 Randomized controlled trials and 4 experimental studies. Most studies demonstrated statistically significant improvements in at least one of the following domains:

- Airway clearance: HFCWO was associated with greater sputum production and more effective mucus clearance compared to traditional chest physiotherapy. (4)
- Pulmonary Function: Studies showed improvement in forced expiratory volume in one second (FEV1), particularly in patients with chronic bronchiectasis and cystic fibrosis. (11,12,15)
- Exercise Capacity: Improvement in 6minute walk test (6MWT) distance were observed in patients receiving HFCWO, indicating enhanced functional endurance. (1)
- Quality of Life: Measured using tools such as the St. George's Respiratory Questionnaire (SGRQ) and Chronic Respiratory Questionnaire (CRQ), patients reported improved health related QOL and symptoms. (3,11)
- The most common comparators were conventional physiotherapy techniques (e.g., postural drainage, percussion), PEP therapy, and Incentive spirometry. In nearly all studies, HFCWO was either equally effective or superior to the comparator. (7)

Discussion

The findings of this evidence-based review reinforce the role of High-Frequency Chest Wall Oscillation (HFCWO) as an effective adjunctive therapy in pulmonary rehabilitation. Its core benefit lies in its ability to enhance airway clearance, improve pulmonary function, and support functional recovery across a spectrum of respiratory disorders with minimal patient effort. (5,6)

HFCWO has been successfully employed in various clinical conditions including chronic obstructive pulmonary disease (COPD), bronchiectasis, cystic fibrosis (CF), asthma, neuromuscular diseases, and thoracic trauma. (7) The device functions by delivering intermittent air pulses via an inflatable vest, which rapidly compresses and releases the chest wall at specific frequencies. This mechanical action facilitates oscillatory airflow within the lungs, enhancing mucus mobilization from peripheral to central airways. (1)

Studies show that HFCWO therapy is comparable or superior to traditional airway clearance techniques in improving sputum expectoration, oxygenation, and spirometry parameters such as FVC, FEV_1, and PEFR. Evidence from HFCWO systems and visual assessments through high-resolution CT and functional respiratory imaging (FRI) suggests that these devices support improved mucus transport and airway ventilation dynamics. [2,3]

A notable advantage of HFCWO is its potential to reduce exacerbation frequency, hospitalizations, and antibiotic use, while also improving patient-reported symptoms and quality of life, particularly in patients with non-cystic fibrosis bronchiectasis (NCFB) and COPD. Its user-friendly design and ability to be self-administered make it especially suitable for home-based care and long-term rehabilitation programs. [2,4]

Despite its proven effectiveness, limitations persist. These include the high cost of devices, limited accessibility in low-resource settings, and heterogeneity in study design and outcomes across the existing literature. Moreover, blinding and allocation concealment were not consistently addressed in many trials, highlighting potential biases.

Conclusion

Based on the number of literatures which have been analyzed, it is evident that high frequency chest wall oscillation device is effective in pulmonary rehabilitation. Moreover, findings shows that it will improve pulmonary function. study revealed that HFCWO is an effective, comfortable and safe modality. It improves mucus clearance, pulmonary function, and exercise tolerance while contributing to better patient-reported outcomes. Its inclusion in rehabilitation protocols is justified, particularly for patients with chronic respiratory diseases characterized by mucus retention.

So, this evidence-based practice is suggested that high frequency chest wall oscillation is patient-friendly modality that significantly enhances the efficacy of pulmonary rehabilitation

References:

1. AbdelAzeem, N. S., Mohamed, M. H. N., Emara, M. M., & Othman, W. N. (2024). Effect of high-frequency chest wall oscillation vest device versus chest physiotherapy on COPD patients' outcome. Mansoura Nursing Journal, 11(2), 215–224.
2. Huang, Y., Xu, M., Xie, Y., Lin, J., & Wang, Y. (2022). Effects of high-frequency chest wall oscillation on acute exacerbation of chronic obstructive pulmonary disease: A systematic review and meta-analysis of randomized controlled trials. International Journal of Chronic Obstructive Pulmonary Disease, 17, 1299–1312. https://doi.org/10.2147/COPD.S363280
3. Camacho Urribarri, M. E., Becker, B. C., & Murray, A. C. (2024). Impact of high-frequency chest wall oscillation on health care resource use and economic outcomes in adult patients with non-cystic fibrosis bronchiectasis in the United States: A pre-post cohort analysis. Chest Pulmonology, 2(1), 100013. https://doi.org/10.1016/j.chpulm.2023.100013
4. Hardy, K. A. (1994). A review of airway clearance: New techniques, indications, and recommendations. Respiratory Care, 39, 440.
5. Tomkiewicz, R. P., Biviji, A., & King, M. (1994). Effects of oscillating air flow on the rheological properties and clearability of mucus gel simulants. Biorheology, 31, 511–520.
6. Majestic, C., Montgomery, M., Jones, R., & King, M. (1996). Reduction in sputum viscosity using high frequency chest compressions compared to conventional chest physiotherapy. Pediatric Pulmonology, Suppl. 13, A3583.

7. Darbee, J. C., Kanga, J. F., & Ohtake, P. J. (2005). Physiologic evidence for high-frequency chest wall oscillation and positive expiratory pressure breathing in hospitalized subjects with cystic fibrosis. Physical Therapy, 85(12), 1278–1289.
8. Phillips, G. E., Pike, S. E., Jaffe, A., & Bush, A. (2004). Comparison of active cycle of breathing and high-frequency oscillation jacket in children with cystic fibrosis. Pediatric Pulmonology, 37(1), 71–75.
9. Oermann, C. M., Sockrider, M. M., Giles, D., Sontag, M. K., Accurso, F. J., & Castile, R. G. (2001). Comparison of high-frequency chest wall oscillation and oscillating positive pressure in the home management of cystic fibrosis: A pilot study. Pediatric Pulmonology, 32(5), 372–377.
10. Mahmoud Ahmed, O. S., Abd El-Rahim Abd El-Aty, S., Ahmed El-Hadidy, H., Mohamed Abdelhakiem, N., & Mohamed El-Moatasem, A. (2024). Efficacy of high-frequency chest wall oscillations vs. lung flute in chronic obstructive pulmonary disease patients with post-COVID. European Review for Medical and Pharmacological Sciences, 28(3), 1227–1233.
11. Nicolini, A., Grecchi, B., Ferrari-Bravo, M., et al. (2013). Effectiveness of treatment with high-frequency chest wall oscillation in patients with bronchiectasis. Multidisciplinary Respiratory Medicine, 8(1), 51.
12. Alahmari, A. D., Alharbi, S., Aldhahir, A. M., et al. (2017). Utility of vest high frequency chest wall oscillation device versus flutter device in acute exacerbation of chronic obstructive pulmonary disease. International Journal of Chronic Obstructive Pulmonary Disease, 12, 3247–3254.
13. Seifer, F. D., Zimmerman, J., Gotfried, M. H., et al. (2020). Real-life experience with high-frequency chest wall oscillation vest therapy in adults with non-cystic fibrosis bronchiectasis. Pulmonary Therapy, 6(1), 55–64.
14. Dufour, A. B., Borrill, Z. L., Thirion, G., et al. (2020). The effectiveness of a mobile high-frequency chest wall oscillation (HFCWO) device for airway clearance: A randomized, open-label, crossover pilot study. Therapeutic Advances in Respiratory Disease, 14, 1753466620915455.
15. Ibrahim, M. M., & Abdellatif, M. E. (2020). Does high frequency chest wall oscillation have an impact on improving pulmonary function in patients with smoke inhalation injury? Egyptian Journal of Chest Diseases and Tuberculosis, 69(3), 523–530.